THEREFORE WHAT IS CLAIMED IS:

1. A liquid-solid circulating fluidized bed system, comprising:

a first fluidized bed, means to feed solid particles having effective immobilized bacteria coated thereon into said first fluidized bed adjacent to a first end of said first fluidized bed and means to feed a first fluid into said first fluidized bed adjacent to a second end of said first fluidized bed, said second end being remote from said first end so that said solid particles and said first fluid flow in counter current;

a second fluidized bed, said second fluidized bed being a riser fluidized bed wherein a means for introducing solid particles and a means for introducing a second fluid into said second fluidized bed are both adjacent to one end of said second fluidized bed so that said solid particles and said second fluid introduced into said second bed flow concurrently through said second bed from said one end toward another end of said second fluidized bed remote from said one end, gas injection means to inject gas into one or both of the first and second liquid fluidized beds;

first means connecting said first fluidized bed to said second fluidized bed adjacent to said second end of said first fluidized bed and said one end of said second fluidized bed, said first connecting means includes means to feed said solid particles into said second fluidized bed; and

second means connecting said first and said second fluidized beds adjacent said first end of said first bed and said other end of said second fluidized bed, said second means connecting includes said means to feed the

solid particles into said first fluidized bed.

2. The liquid-solid circulating fluidized bed system according to claim 1 wherein said gas injection means is connected to the first fluidized bed, and wherein said first fluidized bed includes an aerobic zone for biodegrading wastewater predominantly by the immobilized bacteria in the presence of oxygen.

3. The liquid-solid circulating fluidized bed system according to claim 2 wherein said second fluidized bed includes an anoxic zone for denitrification, and an anaerobic zone for phosphorus release.

4. The liquid-solid circulating fluidized bed system according to claim 1 wherein said gas injection means is connected to the second fluidized bed, and wherein said second fluidized bed includes an aerobic zone for biodegrading wastewater predominantly by the immobilized bacteria in the presence of oxygen.

5. The liquid-solid circulating fluidized bed system according to claim 4 wherein said first fluidized bed includes an anoxic zone for denitrification and an anaerobic zone for phosphorus release.

6. The liquid-solid circulating fluidized bed system according to claim 1

wherein said first means connecting is adapted to form a first hydraulic seal between said first and second fluidized beds, and wherein said second means connecting is adapted to form a second hydraulic seal between said first and second fluidized beds.

7. The liquid-solid circulating fluidized bed system according to claim 6 wherein said first hydraulic seal is a first moving packed bed, and wherein said second hydraulic seal is a second moving packed bed.

8. The liquid-solid circulating fluidized bed system according to claim 1 wherein said first fluidized bed is a counter-current fluidized bed operated in a conventional fluidized bed regime.

9. The liquid-solid circulating fluidized bed system according to claim 1 wherein said second fluidized bed is a riser bed operated in a circulating fluidization regime.

10. The liquid-solid circulating fluidized bed system according to claim 2 wherein said gas injected into the first fluidized bed contains oxygen.

11. The liquid-solid circulating fluidized bed system according to claim 4 wherein said gas injected into the second fluidized bed contains oxygen.

12. The liquid-solid circulating fluidized bed system according to claim 1 wherein said first and second liquid fluidized beds are substantially vertical columns.

13. The liquid-solid circulating fluidized bed system as defined in claim 12 wherein said first end of said first fluidized bed is the top end, said second end of said first fluidized bed is the bottom end, said one end of the second fluidized bed is the bottom end and said other end of said second fluidized bed is the top end.

14. A liquid-solid circulating fluidized bed system as defined in claim 13 wherein said first fluid essentially flows upwards and said solids essentially flow downwards to form a counter current flow in said first fluidized bed, and wherein said second fluid and solid particles both essentially flow upwards concurrently in the second fluidized bed.

15. A liquid-solid circulating fluidized bed system as defined in claim 14 wherein said second fluidized bed further includes a fluid-solid separator means located at the top end thereof for separating solid particles from fluid and exhausting such separated fluid to provide separated solid particles.

16. A liquid-solid circulating fluidized bed system as defined in claim 15 wherein the separator means includes fluid circulating means for circulating at

least some of the exhausted fluid separated from the solid particles back to the bottom end of the second liquid fluidized bed.

17. A liquid-solid circulating fluidized bed system as defined in claim 15 wherein the separator means includes fluid circulating means for circulating at least some of the exhausted fluid separated from the solids back to a middle of the second liquid fluidized bed.

18. A liquid-solid circulating fluidized bed system as defined in claim 15 wherein said first liquid fluidized bed further includes a clarifier means located at the first end thereof for separating solid particles from fluid and exhausting such separated fluid to provide separated solid particles which settle back into the first fluidized bed in order to minimize the loss of particles through the effluent.

19. A liquid-solid circulating fluidized bed system as defined in claim 18 wherein the clarifier means includes fluid circulating means for circulating at least some the fluid separated from the solid particles back to the second end of the first liquid fluidized bed and removing at least a portion of the remaining fluid separated from the solid particles from the system as treated effluent.

20. A liquid-solid circulating fluidized bed system as defined in claim 18 wherein the clarifier means includes sludge withdrawal means for exhausting sloughed sludge formed during the process.

21. A method for biological nutrient removal in a wastewater feed stream to remove carbon, nitrogen and phosphorus therefrom, comprising the steps of:

flowing a raw wastewater feed and a recycle stream into a first fluidized bed and passing solid particles having effective immobilized bacteria coated thereon and a first fluid through the first fluidized bed, the first fluidized bed including a zone maintained under anoxic conditions suitable for denitrification of the first fluid flowing therethrough;

flowing said solid particles with effective immobilized bacteria coated thereon and the first fluid through an anaerobic zone wherein stored phosphorus is released;

separating some of said first fluid from said solid particles with effective immobilized bacteria coated thereon to form said recycle stream and transferring said solid particles and a remaining amount of the first fluid into a second fluidized bed, and mixing said recycle stream with said raw wastewater feed at an input to said first fluidized bed;

passing the particles having effective immobilized bacteria coated thereon with a stream of a second fluid through the second fluidized bed, the second fluidized bed having an aerobic zone under controlled aerobic conditions for biodegradation of constituents of the second fluid in the presence of oxygen to carbon dioxide, water, and nitrates by the immobilized bacteria to produce nitrified effluent from the aerobic zone; and

transferring the solid particles with effective immobilized bacteria coated thereon from said second fluidized bed to the first fluidized bed along with some

of the nitrified effluent and separating the remaining nitrified effluent from said solid particles with effective immobilized bacteria coated thereon and removing a portion of the remaining nitrified effluent from the system as treated effluent and recycling a remaining portion of the remaining amount of the nitrified effluent back into an input to the second fluidized bed to mix with said remaining amount of the first fluid to form the second fluid, and mixing said some of the nitrified effluent with the mixture of raw wastewater feed and the recycle stream at the input of the first fluidized bed to form the first fluid.

22. The method according to claim 21 wherein the solid particles with effective immobilized bacteria coated thereon are flowed in co-current flow with the first fluid through the first fluidized bed, and wherein the solid particles having effective immobilized bacteria coated thereon are flowed in countercurrent flow with the second fluid through the second fluidized bed.

23. The method according to claim 22 wherein the first fluidized bed is operated in the circulating fluidization regime to provide enhanced interfacial mass transfer between the first fluid and the solid particles.

24. The method according to claim 22 wherein the aerobic zone under controlled aerobic conditions in the second fluidized bed is formed by injecting a gas containing oxygen into the second fluidized bed.

25. The method according to claim 22 wherein the first and second fluidized beds are substantially vertical columns, and wherein said second fluid flows upwards and said solid particles flow downwards to flow in countercurrent flow with the second fluid through the second fluidized bed.

26. The method according to claim 22 wherein the second fluidized bed is operated under conditions suitable to give a conventional fluidization regime so that the solid particles flow under gravity to a bottom of the second fluidized bed.

27. The method according to claim 26 wherein the first and second fluidized beds are substantially vertical columns, and wherein said first fluid essentially flows upwards and said solid particles flow upwards to flow concurrently in the first fluidized bed.

28. The method according to claim 27 wherein the anoxic zone is located below the anaerobic zone, and wherein the raw wastewater feed and the recycle stream are flowed into the first fluidized bed below the anoxic zone.

29. The method according to claim 27 wherein the anoxic zone is located above the anaerobic zone, and wherein the recycle stream and part of the raw wastewater feed is flowed into the first fluidized bed below the anaerobic zone, and wherein the remaining part of the raw wastewater feed and the nitrified effluent from the aerobic zone is flowed into the first fluidized bed between the

anaerobic zone and the anoxic zone.

30. The method according to claim 22 wherein the step of transferring said solid particles and a remaining amount of the first fluid into a second fluidized bed includes forming a moving packed bed between the first and second fluidized beds.

31. The method according to claim 22 wherein the step of transferring the solid particles with effective immobilized bacteria coated thereon from said second fluidized bed to the first fluidized bed along with some of the nitrified effluent includes forming a moving packed bed between the second and first fluidized beds.

32. The method according to claim 22 including a step of removing sloughed sludge formed during treatment of the wastewater.

33. The method according to claim 32 wherein the sloughed sludge is removed from the second fluidized bed.